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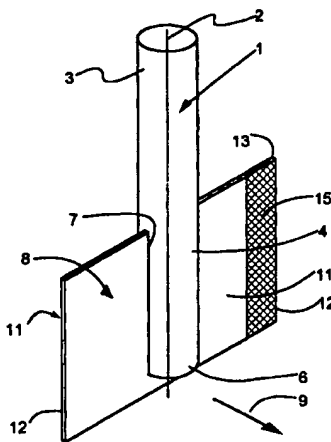
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[Fortsetzung auf der nächsten Seite]

(54) Title: SHAFT TOOL WITH FIXEDLY DISPOSED WINGLIKE INSERTS

(54) Bezeichnung: SCHAFTWERKZEUG MIT FEST ANGEORDNETEN FLÜGELARTIGEN EINSÄTZEN



(57) Abstract: The invention relates to a simple shaft tool than can be produced in an easy and economical manner. Said tool comprises fixedly disposed winglike inserts for milling-type machining of non-chip forming materials and remains operational during unavoidable abrasive wear and increased wear and tear. According to the invention, the shaft tool is characterized by a shaft (1) that can rotate around its longitudinal axis (2). Said tool can be releasably connected to a drive device and is fitted with at least one groove-like recess (7) extending in axial direction and a flat cutting blade (8) on the free end segment (6) of the tool, said blade being provided on the front side with a non-cutting edge (12) when viewed from the direction of displacement (9). The shaft tool is used in the production of molds, more particularly heat-resistant casting molds for manufacturing of cast parts made of metal.

(57) Zusammenfassung: Die Erfindung betrifft ein einfaches und kostengünstig herstellbares Schaftwerkzeug mit fest angeordneten flügelartigen Einsätzen zur fräsartigen Bearbeitung von nichtspanbildenden Werkstoffen, das bei einem nicht vermeidbaren Reibverschleiss und bei zunehmender Abnutzung funktionsfähig bleibt. Erfindungsgemäss ist das Schaftwerkzeug durch einen um seine Längsachse

[Fortsetzung auf der nächsten Seite]

WO 01/00351 A1

Extreme wear resistance and extended tool life help maximize high-speed CNC machining centers.

■ By Ed Kwasnick

Diamond Tames Graphite's Bite

Is the old adage, "The machine is only as good as the tool in it," correct? What is correct is that CNC machining centers are the high-tech machines capable of increasing graphite electrode production in your shop.

Their high rpm coupled with their multiaxis feeds permit the machining of the complex profiles required in today's graphite electrodes. Add the CNC programmer's knowledge and the correct tooling, and you have a winning combination for definitely increasing electrode production.

Using a specific endmill will either decrease, limit, or maximize the machining center's ability to machine graphite electrodes. The endmill must be capable of performing under the maximum machine functions that a combination of the machine's capabilities and part requirements will allow.

A CNC machining center that can mill a graphite electrode at 15,000 continuous rpm and 300 ipm will not do so if the endmill has one cutting edge (PCD-style endmill) and/or cannot withstand the high rpm (carbide endmill). The endmill must have a combination of multiflute geometries and extreme wear resistance. It is only then that the endmill will support the machine's functions, and graphite-electrode production will increase.

Coating Technology

CVD diamond-coated endmills are coated with diamond through a chemical-vapor deposition (CVD) process. The first step in this process is a quality inspection for grind uniformity and cutting-edge chips, since the diamond coating will follow the endmill's contours. The slightest imperfection on the cutting edge of the endmill will be evident in the cut taken on the graphite electrode by leaving a ridge or groove

The next step is the coating preparation process, which includes surface treatment and cleaning of the endmill. The surface treatment is a process that enables the diamond to adhere to the carbide substrate by creating voids within the surface of the substrate. Cleaning is extremely important. A speck of foreign matter on the cutting edge of the endmill will become coated, and the endmill will be scrapped in final inspection.

If this problem is overlooked, and the endmill is sent to a customer, he or she will immediately experience a depressed line in the graphite electrode caused by the coated speck on the endmill. The time involved in inspecting and preparing endmills assures that the endmill is ready for diamond coating.

The actual CVD diamond coating is then accomplished by placing the prepped endmill in a unit called a reactor. A combination of intense heat and injected gases creates an atmosphere within the reactor that causes a chemical change which, in turn, begins a growth of continuous diamond film on the endmill. The result over a specific time period is a diamond coating of approximately 0.0006" thickness, which is now bonded to the carbide substrate (Figure 1).

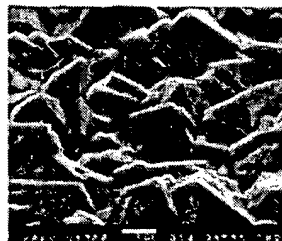


Figure 1: A photomicrograph of the diamond coating on an endmill.

The reason for the 0.0006" coating thickness is that it is optimum for retaining cutting-edge sharpness while still offering extreme wear

resistance. The endmill's cutting-edge sharpness is about that of a slightly honed cutting tool edge, which is ideal for graphite applications. Basically the cutting edge is no longer in an up-sharp, feathered-edge condition, which actually adds strength to the cutting edge, but still permits the endmill to perform thin-wall and finish-machining applications.

The high wear resistance is because the CVD diamond coating process provides a pure diamond film free of any metallic binder. The uniformity of the coating is within 10% of the coating thickness, or 0.00006" in variation. To compensate for the added coating thickness, the solid-carbide endmill flute diameter is initially ground undersize. The shank of the endmill is not coated.

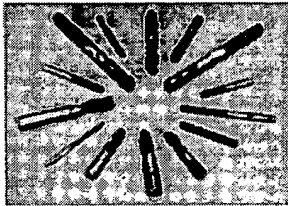


Figure 2: CVD diamond-coated endmills from sp³.

CVD diamond coated endmills are manufactured in 2-, 3-, and 4-helical-flute geometries, and in both ball and square-end styles. The diameter range is from 0.093" to 0.500". Endmill lengths up to 6.000" are available. Special sizes, tapers, end configurations, etc. are usually manufactured on a quotational basis. The endmill sizes are governed by standard endmill tolerances (Figure 2).

Old, Proven Tool Geometries

As mentioned earlier, an endmill that will maximize the CNC machining center's performance must have a combination of multiflute geometries and extreme wear resistance when machining graphite electrode materials.

Chipload per flute (cutting edge) is the basis for establishing machining feed rates by considering a combination of part finish requirements, profile configurations, available continuous rpm and other factors. Figure 3 provides recommended parameters for different endmill diameters.

In the following examples, let's assume that a chipload per flute of 0.005" is required in a specific graphite electrode machining application.

Example #1, single-flute

endmill: A chipload per flute of 0.005" on a single-flute cutter will yield a feed per revolution of 0.005" (0.005" X 1 flute = 0.005 ipr). If we carry this further by introducing a machine rpm of 7000, we will have a feed rate of 35 ipm (0.005 ipr X 7000 rpm = 35 ipm feed rate).

Endmill dia. (in.)	Operation	Machine speed (rpm)	Cutting speed (rpm)	Feed rate (ipr)
1/16	Rough Finish	6000 to 90,000	200 to 3000	0.001 - 0.002 0.0005 - 0.001
3/32	Rough Finish	4000 to 60,000		0.001 - 0.002 0.0005 - 0.001
1/8	Rough Finish	3000 to 45,000		0.002 - 0.004 0.001 - 0.002
5/32	Rough Finish	2500 to 37,000		0.002 - 0.004 0.001 - 0.002
3/16	Rough Finish	2000 to 31,000		0.003 - 0.005 0.001 - 0.003
1/4	Rough Finish	1500 to 23,000		0.003 - 0.005 0.001 - 0.003

Figure 3: The recommended starting parameters for endmilling graphite, carbon, and unfilled plastics with CVD diamond-coated tools.

Example #2, 4-flute endmill: A chipload per flute of 0.005" on a 4-flute cutter will yield a feed per revolution of 0.020" (0.005" X 4 flutes = 0.020 ipr). If we again carry this further by introducing the same machine rpm of 7000, we will have a feed rate of 140 ipm (0.020 ipr X 7000 = 140 ipm feed rate).

The examples above readily illustrate the increased (4:1) feed rate opportunity by using a 4-flute endmill vs. a single-flute cutter. Obviously, a 2- or 3-flute endmill will have specific related feed-rate increases over a single-flute cutter.

Additionally, a helical, multiflute, CVD diamond-coated endmill provides more machining stability in the cut than a single-cutting-edge tool, i.e. PCD (polycrystalline diamond) endmill. The increased cutting stability comes from the multiple cutting edges simultaneously removing material while utilizing the cutting action of helical-flute tooling geometries.

Depending on the feed direction, it is possible to have three cutting edges of a 4-flute endmill in a cut at the same time. The endmill is in a "balanced cut" configuration which causes improved finishes, reduced tool pressure, etc. Additionally, depending on the feed direction, radial tool pressures are reduced and replaced by axial tool pressures

which are transferred accordingly into the spindle.

Extreme Wear Resistance

Tool life is an important issue. Graphite, as we all know, is abrasive. As soon as an endmill starts to cut into a block of graphite, tool wear begins. The amount of tool wear is directly related to the graphite grade, machining parameters, and to the cutting tool material.

If the endmill immediately loses its cutting-edge sharpness (the actual feathered edge only), there is not a noticeable difference in machining. The endmill is now in a honed edge state caused by the abrasiveness of the graphite. If it continues cutting in a honed edge state, tool life will also continue.

However, if the endmill experiences increased wear, a rapid decrease in tool life will also be experienced. The endmill's cutting edges are now dulled beyond that required to efficiently machine the material. This, in turn, causes a variety of tool pressure machining problems (i.e., part-finish loss, breakout, chipping, part-tolerance loss, etc.).

All of these problems add up to remachining and/or scrapping of the electrode. Either way, the CNC machining center must be stopped and the endmill changed. During this tool-change downtime mode, the tool must be replaced, touching off accomplished, and the previous cut picked up (for remachining) somewhere in the worn tool's cut path. Cutting air or recutting an area is certainly not adding to increasing graphite electrode production. Operator efficiency can also affect downtime.

Tool life is an extremely important key to keeping your graphite machining center not just running, but efficiently machining graphite.

If we consider all of the multiflute endmill materials and coatings on the market today, CVD diamond is far superior in tool life to any other. Documented testing and constant use in actual graphite machining facilities have proven that CVD diamond-coated endmills have a tool life increase of up to 50:1 over carbide endmills.

Graphite electrode manufacturing facilities have taken advantage of the CVD diamond-coated endmill's extreme tool life increase by running their CNC machining centers in a lights-out environment, to find a large, completely machined, finished electrode within tolerance upon their return. Other graphite-electrode producers have used the same CVD diamond-coated endmill on multiple electrodes without losing size. And in another documented graphite electrode application, a CVD diamond-coated endmill was run for 153 hours, and was then set aside for roughing applications only.

A major U.S. manufacturer of graphite electrode materials has found that using a specific manufacturer's CVD diamond-coated endmills has improved his tool life 33:1 as compared to carbide endmills.

All of this extensive documentation and related constant use of CVD diamond-coated endmills proves that they are maximizing the performance of graphite-electrode machining centers through extreme tool life improvements and multiflute geometries.

Putting CVD Diamond to Work

CVD diamond-coated endmills offer the two absolute necessities for maximizing graphite-electrode production on your CNC machining center by offering multiflute geometries and extreme wear resistance.

It is the extreme wear resistance of the CVD diamond-coated endmill that will permit your machining center to operate at any rpm that you desire. Attempting to maximize the use of your graphite machining center at high rpm with carbide endmills cannot be accomplished due to their lack of tool life.

PCD endmills have excellent wear resistance in graphite machining at high rpm, but do not have the multiple helical-flute geometries to perform at the feed rates of CVD diamond-coated endmills. In documented testing and daily applications, we have yet to find a CNC machining center used on machining graphite electrodes that has an rpm

capability beyond the wear resistance limitations of CVD diamond-coated endmills.

If we use the previous example of a 4-flute CVD diamond-coated endmill operating at 0.020 ipr (0.005" chip load/flute), we can obviously calculate a variety of feed rates per minute, depending on the desired rpm. As the rpm increases, the feed rate per minute also increases.

Maintaining a specific feed per revolution suitable for the machining application and increasing the rpm will directly reduce the time required to machine a graphite electrode. Basically, the endmill is retaining the feed per revolution necessary for part finish requirements while operating at an increased feed/minute due to the rpm increase.

Thin-wall sections will require increased rpm and reduced feed per revolution to limit cutting pressures, while roughing passes can be done at both increased rpm and higher feed per revolution. The important point is that the highest possible rpm be used with feed per revolution variations suitable for the endmill size and for the specific electrode profiles being machined. By using a combination of feed rates per revolution and rpm, maximum machining parameters can be constantly maintained.

CVD diamond-coated endmills are the highest technology cutting tools available for increasing graphite electrode production. CNC machining centers are the highest technology machine tools available for increasing graphite-electrode production.

Your graphite-electrode production will definitely increase by using CVD diamond endmills to support the maximum possible machining parameters of your graphite machining center.

About the Author

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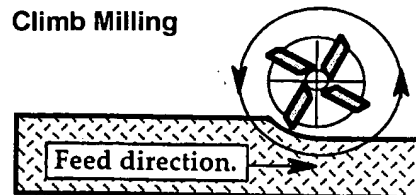
ES51: INTRODUCTION TO MILLING

Spring 2003

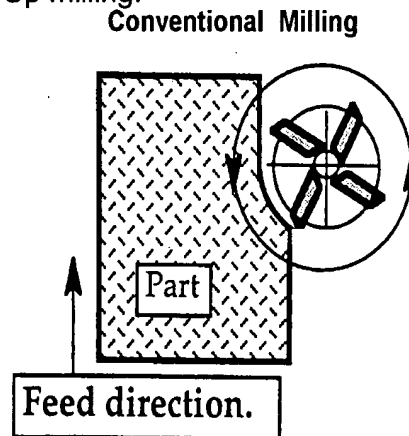
End mills are used for producing precision shapes and holes on a milling machine. The correct selection and use of end milling cutters is paramount. End mills are available in a variety of design styles and materials.

TYPES OF MILLING PROCEDURES

Climb Milling - Cutter direction for a milling operation. The cutter tending to "Climb" into the workpiece, relieving feed force requirements. First choice for CNC machining. Increases cutter tool life. Sometimes called down milling.



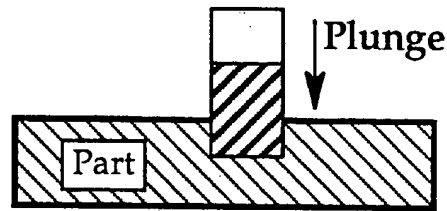
Conventional Milling - Cutter direction for a milling operation. The cutter tending to push the workpiece away from the part, increasing the required feeding force. First choice for manual machining. Sometimes called Up milling.



End Milling - Metal removal process that is achieved by feeding a workpiece into a revolving cutter. The cutter will remove material as chips.

Peripheral Milling - The machining of an edge surface of a part. Peripheral milling is accomplished by presenting the workpiece to the circumference or the periphery of the milling cutter.

Plunge Cut - Axial feeding into a part. CNC machine movement in the Z-axis direction. Direct plunging into the face of a part. Plunge feeding in a axial direction. Requires a center cutting End mill.



END MILL TYPES

Flutes - Spiral cutting edge on the end mill. 2 and 4 flute end mills are the most commonly used.

- **2-Flute** - Allows maximum space for chip ejection. Used for general milling operations.
- **3-Flute** - Excellent for slotting. Used for general milling operations.
- **4, 5, 6, and 8 Flute** - A greater number of flutes reduces chip load and can improve surface finish, if feed rate remains the same.

Ball End - Used to mill die cavities and fillets, round bottom holes and slots.

Double End - An end mill that has teeth on both ends of the cutter. End mill holders must have sufficient clearance to allow for the use of a double end cutter.

Rougher (Hoggers) - End mill with interrupted shape on outside diameter to remove large amounts of material quickly. Typically can remove material up to three times the rate of conventional end mills with different types available to achieve the desired finish on the material.

Single End - Teeth on one end of the cutter only. This style is the most common available.

All types of end mills must be handled with care. This is particularly important when storing in the Tool Crib. Tools should be stored in a tube protector or dipped in a protective coating. Tool life will be significantly shortened if the tool edge is damaged.

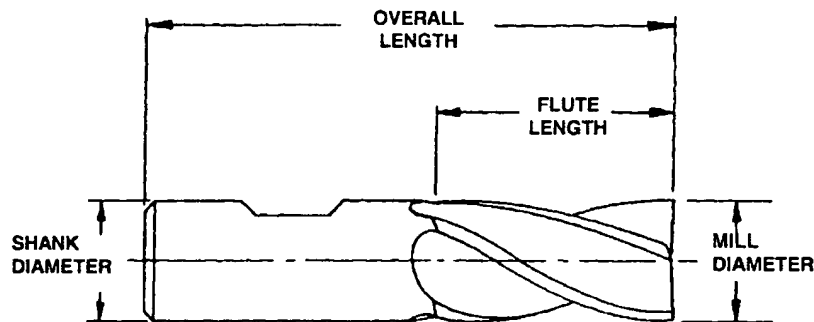
END MILL MATERIAL TYPES

Carbide - This tool material combines increased stiffness with the ability to operate at higher SFPM. Carbide tools are best suited for shops operating newer milling machines or machines with minimal spindle wear. Rigidity is critical when using carbide tools. Carbide end mills may require a premium price over the cobalt end mills, but they can also be run at speeds 2 1/2 faster than HSS end mills. For best results mount in a hydraulic type holder.

Cobalt - Type of high speed steel tool which has a 8% cobalt content. This material has excellent abrasion resistance for improved tool life over standard high speed steel.

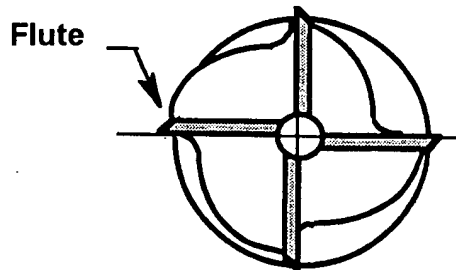
HSS - A baseline tool steel. In the past, a majority of end mills were made from standard High Speed Steel. Usually inexpensive, but do not offer the tool life or speed and feed advantages of Cobalt and Carbide end mills.

END MILL DESIGN CRITERIA



Cutting Edge - The leading edge of the cutter tooth. The intersection of two finely finished surfaces, generally of an included angle of less than 90 degrees.

Flute - Space between cutting teeth providing chip space and regrinding capabilities. The number of cutting edges. Sometimes referred to as "teeth" or "gullet". The number on an end mill will determine the feed rate.



Flute Length - Length of flutes or grooves. Often used incorrectly to denote cutting length.

Shank - The projecting portion of a cutter which locates and drives the cutter from the machine spindle or adapter.

Tooth - The cutting edge of the End mill.

SPEEDS AND FEEDS

IMPORTANT TERMS

Chip load - The amount of material removed by each flute of the cutter.

Feed Rate or Feed per tooth - The inches per minute of workpiece movement toward the cutter between each tooth

Inches Per Minute (IPM) - The number of linear inches the cutter passes through the workpiece in one minute

Depth of Cut (DOC) - The depth of cut of the end mill into the part surface axially. With CNC milling, it is measured in the Z axis direction.

Inches Per Revolution (IPR) - Feed rate of the cutter for each revolution of the cutter. In the inch system, the feed rate of the cutter can be calculated for each revolution of the cutter.

$$\text{I.P.R.} = \text{Chip load} \times \text{Number of flutes}$$

Revolutions Per Minute (RPM) - The spindle speed rate of the cutter. This value will be calculated from a selected S.F.P.M. or MPM.

Surface Feet Per Minute (SFPM) - This is the cutting speed of the end mill in the United States. It is the number of feet per minute that a given point on the circumference of a cutter travels per minute.

SELECTING SPEED AND FEED RATES AND THE DEPTH OF CUT

The following items must be selected by the machinist / programmer when using end mills.

- SFPM - cutting surface speed
- Chip Load - material removal rate
- Depth of Cut - depends on specific part applications requirements
- Considerations - cutting depth never to exceed flute length

Excessive depth of cut will result in tool deflection. As required, the depth of cut increases use the largest diameter cutter available to maintain a depth to diameter ratio of 1 : 1. Width of Cut - (maximum amount should not exceed 2/3 x Cutter diameter)

MACHINING FORMULAS
S.F.M. = 0.262 x D x R.P.M.
R.P.M. = (3.82 x S.F.M.) / D
I.P.R. = I.P.M. / R.P.M. or CHIP LOAD x F
I.P.M. = R.P.M. x I.P.R.
CHIP LOAD = I.P.M. / (R.P.M. x F) or I.P.R. / F
LIST OF SYMBOLS
F = NUMBER OF FLUTES
D = DIAMETER OF CUTTER
R.P.M. = REVOLUTIONS PER MINUTE
S.F.M. = SURFACE FEET PER MINUTE
I.P.M. = FEED RATE: INCHES PER MINUTE
I.P.R. = FEED RATE: INCHES PER REVOLUTION

For Premium Cobalt High Speed Steel (M42) and regular High Speed Steel (M7) End Mills, the following speeds and feeds are recommended by Melin Tool

MATERIALS	CAST IRON, MILD STEEL, HALF HARD BRASS AND BRONZE		BRASS, BRONZE, ALLOYED ALUMINUM, ABRASIVE PLASTICS		ALUMINUM, PLASTICS, AND WOOD	
	SPEED 80- 100 SFM	FEED	SPEED 100-200 SFM	FEED	SPEED 200-600 SFM	FEED
DIA. OF END MILLS	RPM	CHIP LOAD PER TOOTH	RPM	CHIP LOAD PER TOOTH	RPM	CHIP LOAD PER TOOTH
1/8	2440-3056	.0002 -.001	3056-6112	.0002 -.001	6112 UP	.0002 -.001
1/4	1222-1528	.0005 -.002	1528-3056	.0005 -.002	3056-9168	.0005 -.002
3/8	815-1019	.001 -.003	1019-2038	.0005 -.003	2038-6114	.0005 -.002
1/2	611-764	.001 -.003	764-1528	.0005 -.003	1528-4584	.0005 -.002

Adapted from www.endmill.com.

ACTech GmbH

company

performances

references

news



technologies

CAD

Reverse Engineering

Laser-Sintering

Direct Mold Milling

CNC-patternmaking

mold assembly

foundry

heat treatment

test laboratory

CNC-milling

business segments

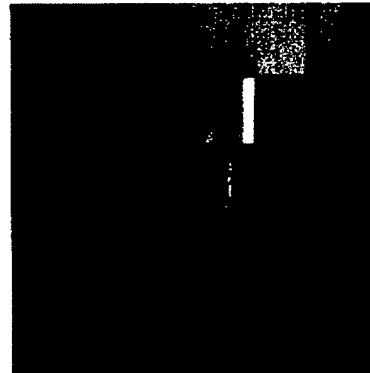
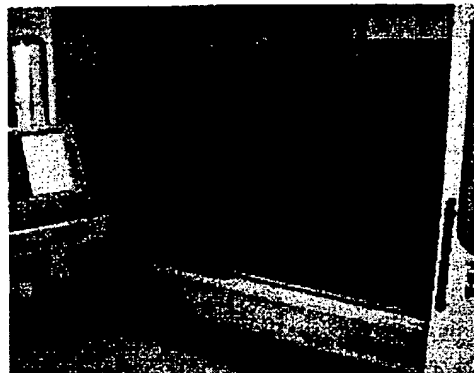
DIRECT MOLD MILLING (DMM)

VIDEO

technology

Since summer 1999, **ACTech** have also used milling of the molding material as a new mold making technology in addition to known Direct Craning® techniques. This procedure is able to generate mold segments with sizes much bigger than the known building dimensions of laser sintering equipment. At present, **ACTech** use equipment for mold segments up to an external dimension of 2.5 m. To give only a few examples of how to use this new technology, we should mention the manufacture of large-surface car body structures that are produced as die cast parts in later series production or as pre-casted patterns accurate in size and able to reduce milling time for dies to a fraction.

Even in this procedure, it is not necessary to produce a pattern equipment which is consuming a lot of costs and time. The mold is directly milled into a block of molding material. The size of the applied mold is only limited by the mechanical strength of the molding material used and the available milling equipment.



Sitemap

Impressum

© ACTech GmbH

Thus, the production of sand casting prototypes only depends on the available pouring capacity.

In conjunction with the possibilities of laser sintering, using combinations of methods, not only large, but also very complicated, castings can be produced as prototypes or small batches in short time and at low cost.

Features

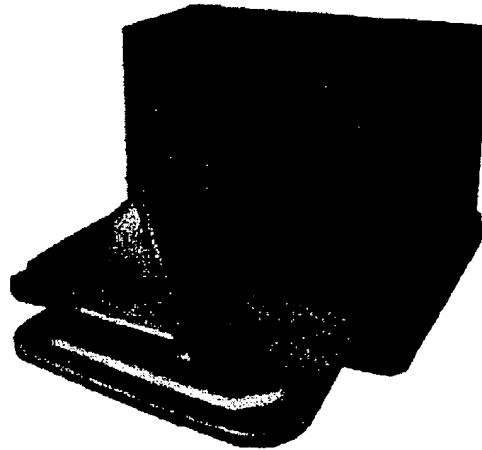
The five-axis CNC-milling machine used at ACTech allows dimensions up to 2.400 x 1.400 x 1.400 mm for a single mould segment. However, by dismantling of the needed mould in segments, larger moulds can be set up.

During the mould assembly, critical measures can be checked and corrected all the time.

Benefits

- time and cost saving technique for prototyping castings moulds
- especially for larger moulds or cores
- the range of castable materials include all sand casting alloys
- resulting qualities are similar to series pieces
- comparable results can be obtained even in the pilot-plant stage
- high accuracy together with the feasibility's of Laser sintering

example



Oil filter bracket for a diesel engine

Material: GG 25

Casting dimension: 420 x 320 x 180 mm

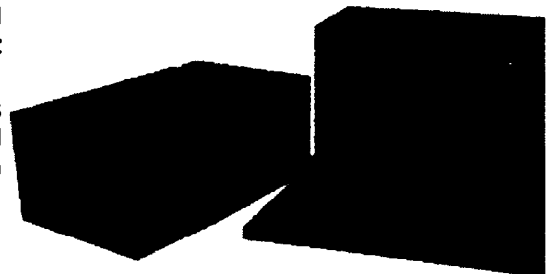
Lead time: 8 days for 2 machined castings:
(from receiving the CAD data, including the machining)

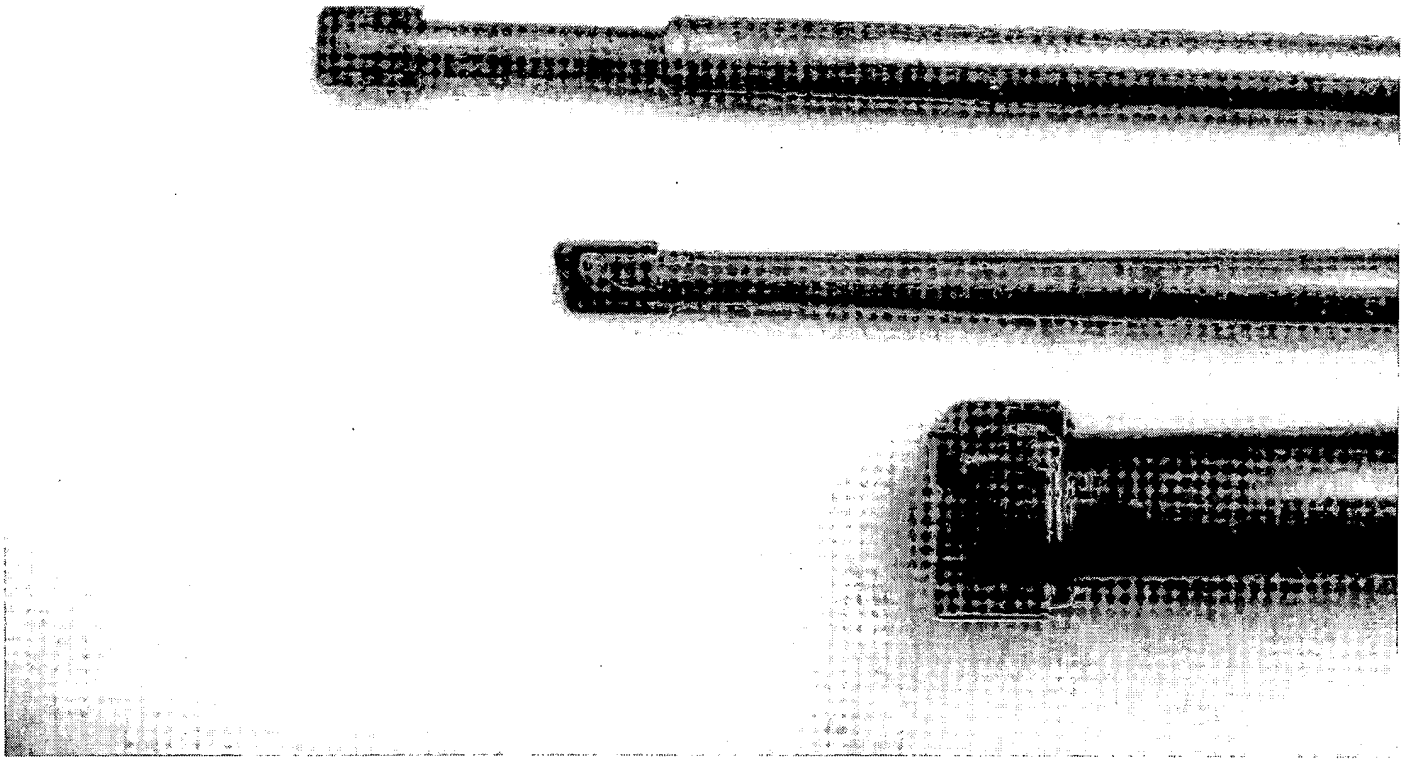
Mould segments and core for an oil filter bracket

Milling data generation: 3 hours

Mould milling: 6,5 hours each mould

Casting dimension: 600 x 500 x 340 mm





Tools according
to Hanschild
invention

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Sand Mold & Core Prototyping

As with all castings, this prototyping process begins with a CAD file of the component as delivered by the casting design engineer. This file then must be reconfigured, following steps similar to those used to machine patterns. For cores, the internal passages must be separated from the external geometry, the core prints must be designed and, using computer aided manufacturing software, the tool paths must be brought together. Once the mold and/or core design is complete, it is inputted into the CNC machining system configured for the sand block. The system runs automatically.

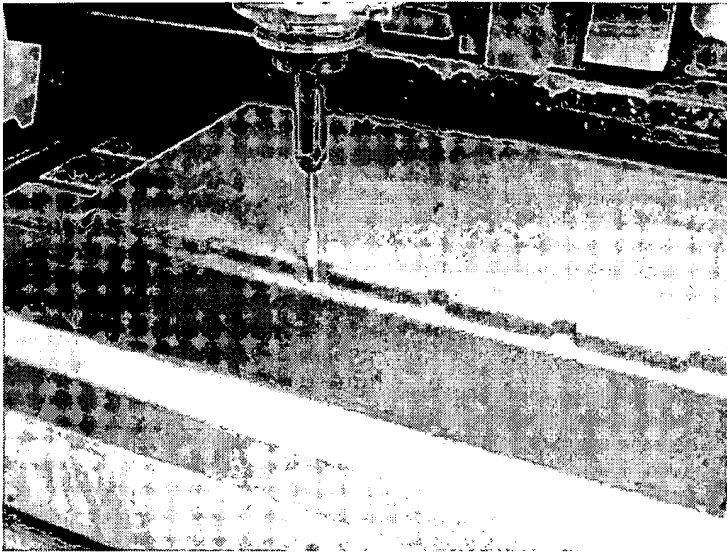
The cured sand blocks for machining have been produced via the nobake and coldbox processes with binder levels as low as 0.8-1% and as high as 3%, depending upon the application. The key to this stage of the process is efficient sand mixing to ensure that all the grains are coated thoroughly with binder. Therefore, when the reaction (through mixing or gassing) occurs, the entire sand block is cured through. Although some soft pockets of undercured sand in core and mold production can be ignored in production foundries because they will not affect the casting, a soft pocket uncovered during sand block machining will result in a scrapped core or mold.

Machining a block of cured sand is a more delicate process than machining metal. Sand machining is a dry process without lubricant. When machining the sand blocks, a fluid diamond cutter passes more times across the block of sand to machine the shape of the mold and/or core. The sand block will chip, crack and/or fragment with any imperfection (inconsistency in curing).

The largest cores and/or mold halves produced measure up to 30 x 60 in. This allows large cores and/or molds to be produced in one piece as well as the production of multiple cores and/or molds from one sand block. Once machined, the cores and/or molds are ready for casting.

The downside to the core and mold production system is the surface finish of the final prototype castings produced. The passes made by the diamond cutter on the cured sand block result in a stair-stepping surface on the resultant cores and/or mold halves, which is then replicated on the castings. This downside can be controlled by the cutter direction, cusp height and/or the use of hand finishing on the affected area of the mold/core. Another factor that must be considered is the size of the machining envelope.

Currently, the process has been used to produce mold halves and cores for iron, aluminum and magnesium prototype casting. Once the appropriate binder system has been developed, steel casting production will be available.



The prototyping process is the machining of a cured sand block to produce cores or cope and drag mold halves for the production of prototype and small run cast components.



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United States Patent [19]

Schmidt

[11] Patent Number: 4,915,309

[45] Date of Patent: Apr. 10, 1990

[54] ROTOR FOR A REBOUND CRUSHER

[75] Inventor: Horst H. Schmidt,
Bergisch-Gladbach, Fed. Rep. of
Germany

[73] Assignee: Deutscher SBM Vertrieb Franz
Wagener, Hagen, Fed. Rep. of
Germany

[21] Appl. No.: 283,636

[22] Filed: Dec. 13, 1988

[30] Foreign Application Priority Data

Dec. 15, 1987 [DE] Fed. Rep. of Germany 3742395

[51] Int. Cl.⁴ B02C 13/26; B02C 13/28

[52] U.S. Cl. 241/191; 241/197

[58] Field of Search 241/191, 192, 197

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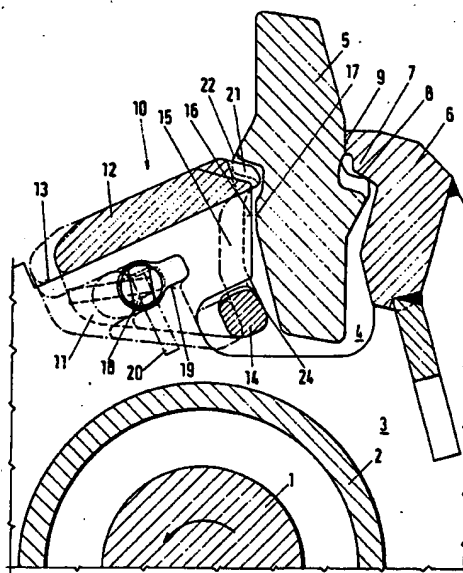
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Primary Examiner—Timothy V. Eley
Attorney, Agent, or Firm—Sprung Horn Kramer &
Woods

[57] ABSTRACT

The invention relates to a rotor for a rebound crusher in which the beater blades (5), retained in marginal recesses (4) in rotor discs (3) are positively retained by an axial locking system (7, 8) disposed on the rear side of the beater blades (5). On the front side of the beater blades (5) protective caps (10) are disposed on the discs (3) to maintain the axial positive locking system (7, 8) and protect the discs (3). To secure the beater blades (5) against axial displacement, the beater blades (5) are secured by a positive locking system comprising a recess (22) and a nose (21) engaging therein with clearance. To keep the protective cap (10) free from loading by the beater blade (5), in the side of the protective cap (10) adjacent the beater blade (5) a window (24) is provided into which a projection (15) of the disc (3) extends which forms an abutment (16) for a bearing surface (17) of the beater blade (5).

5 Claims, 1 Drawing Sheet



United States Patent

Fairweather et al.

[15] **3,695,722**[45] **Oct. 3, 1972**

- [54] **APPARATUS FOR TREATING OR DIGGING INTO SURFACES AND CUTTING MEMBERS FOR THIS APPARATUS**
- [72] Inventors: Ernest Sidney Fairweather, London;
Jim Furby, Kirby Muxloe, both of
England

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- [73] Assignee: **Errut Products Limited**, London,
England

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- [22] Filed: **Feb. 18, 1970**

Primary Examiner—Ernest R. Purser

- [21] Appl. No.: **12,336**

Attorney—Irving M. Weiner

- [30] **Foreign Application Priority Data**

Feb. 27, 1969	Great Britain.....	10,628/69
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- [52] U.S. Cl.299/39, 173/99, 299/85

- [51] Int. Cl.E01c 23/09

- [58] Field of Search299/39, 85, 86, 37; 173/98,
173/99

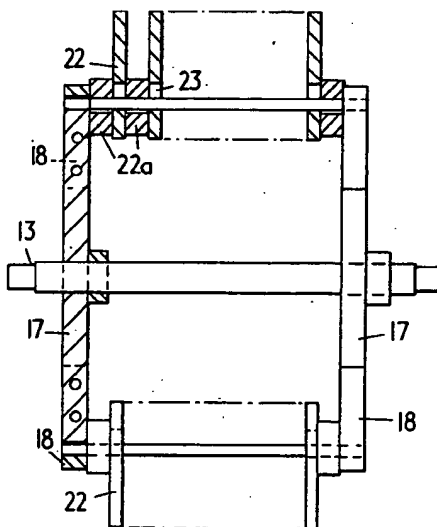
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[57] **ABSTRACT**

Apparatus for planing or cutting a surface of hard material including a plurality of support rods mounted between two support members and extending parallel to each other, each support shaft carrying a plurality of cutting members or tines rotatably mounted thereon through elongated apertures and moving means for rotating the support members in an orbital path so that, after impact with the surface of material, the cutting members can be returned to a position approximately along the radial component extending outwardly from the orbital path before the next succeeding impact of that cutting member.

13 Claims, 23 Drawing Figures

United States Patent [19]

Scheler

[11] Patent Number: **4,848,682**[45] Date of Patent: **Jul. 18, 1989**[54] **DOUBLE BLADED ROCK CRUSHER**[76] Inventor: **Morris Scheler, Star Rte., Box 305, Magnet, Ind. 47555**[21] Appl. No.: **200,360**[22] Filed: **May 31, 1988**[51] Int. Cl.⁴ **B02C 13/28**[52] U.S. Cl. **241/190; 241/191; 241/285 B; 241/286**[58] Field of Search **241/189 R, 190, 189 A, 241/191, 285 B, 188 R, 188 A, 243, 286**[56] **References Cited****U.S. PATENT DOCUMENTS**

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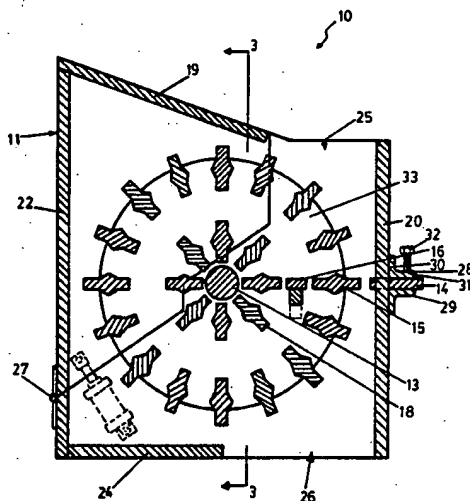
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Primary Examiner—Mark Rosenbaum
Attorney, Agent, or Firm—Scott R. Cox

[57] **ABSTRACT**

This invention discloses a rock, stone or other solid material crushing device. It consists of a crushing chamber, a rotator shaft running through the chamber, an outer cutting blade secured to the chamber, a set of outer cutting bars which are secured to a disk which is secured to and rotates with the rotator shaft and acts as a mechanism for breaking apart the solid material to be crushed. Within the rotational arc of the outer cutting bars is a pair of inner cutting blades. Inside of the inner cutting blades and attached to the rotator shaft disk is a second set of cutting bars, i.e. the inner cutting bars. The inner cutting blades are secured to the outside of the crushing chamber and intrude into the crushing chamber such that the outer cutting bars rotate outside of the pair of inner cutting blades and the inner cutting bars rotate inside the inner cutting blades. This crushing device provides three locations for the breaking apart of the solid material, a vast improvement over prior art devices which only provided one crushing or breaking mechanism within each crushing chamber.

10 Claims, 4 Drawing Sheets

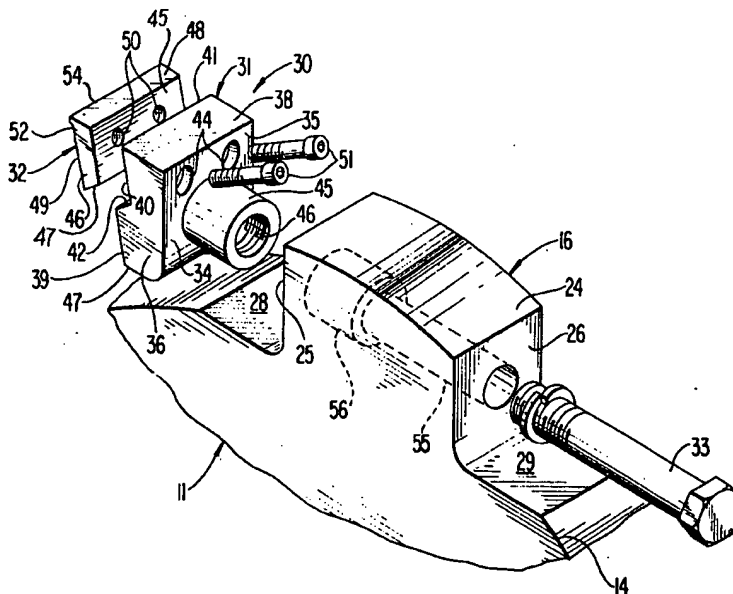
United States Patent**Blackwell, Jr.**[15] **3,642,214**[45] **Feb. 15, 1972****[54] CUTTER TOOTH ASSEMBLY FOR GRINDER**[72] Inventor: **George T. Blackwell, Jr.**, P.O. Box 278, Oneonta, Ala. 35121[22] Filed: **Jan. 19, 1970**[21] Appl. No.: **3,984**[52] U.S. Cl. **241/191, 241/197**[51] Int. Cl. **B02c 13/06, B02c 13/28**[58] Field of Search **241/86, 88, 189, 190, 191, 241/195, 197, 291, 294, 298, 300; 146/305, 308****[56] References Cited****UNITED STATES PATENTS**

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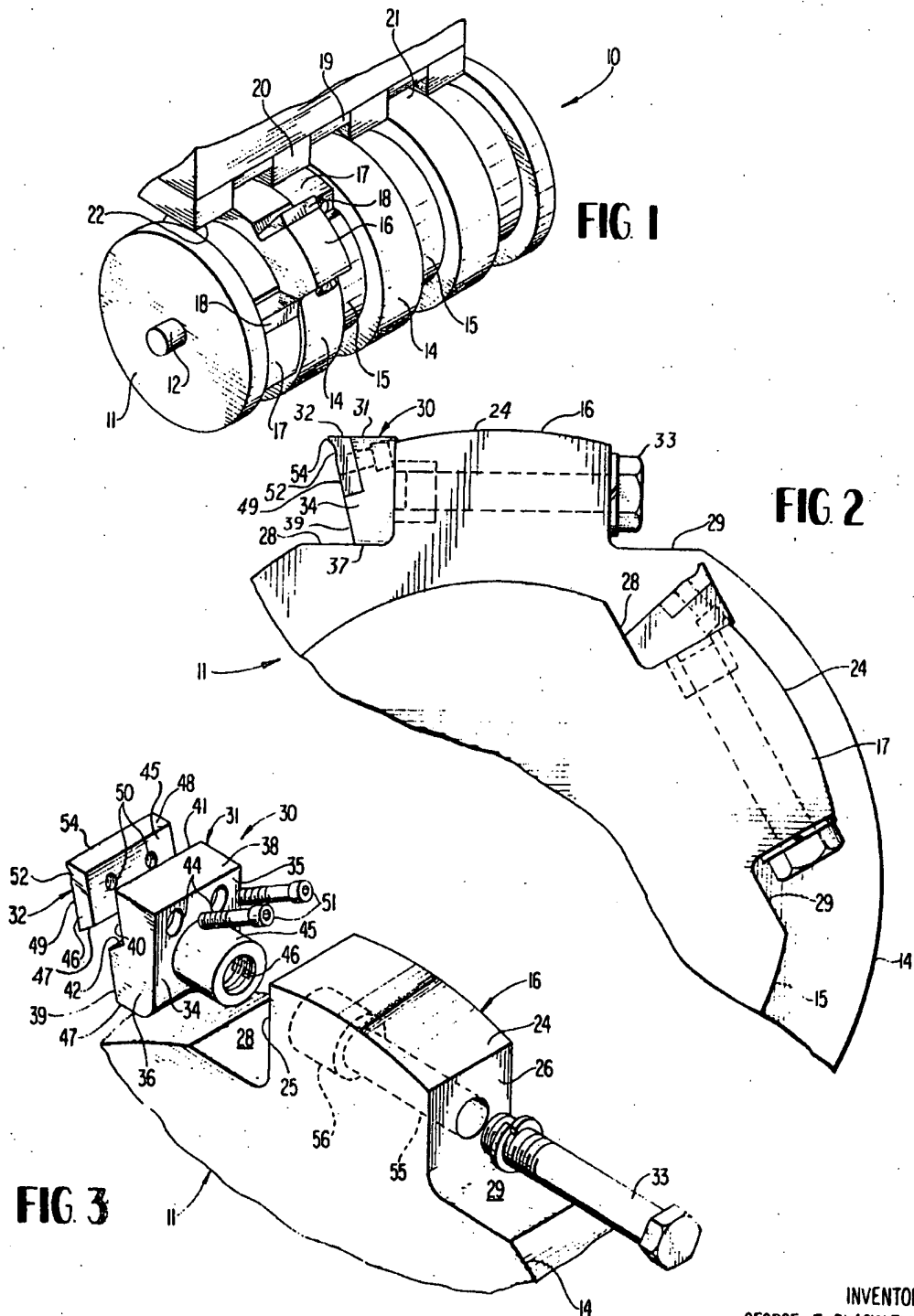
Primary Examiner—**Robert L. Spruill**Attorney—**Jones & Thomas****[57] ABSTRACT**

The cutter tooth assembly for a rotor of a grinder of the type used for grinding wood, scrap or the like. The grinder comprises a rotor having alternate large and small diameter breaker rings with at least one breaker head protruding from each breaker ring. The cutter tooth assembly comprises a holder having a boss or stem inserted into the leading surface of the breaker head. A small, relatively inexpensive cutting blade is attached to the leading surface of the holder and makes primary contact with the material being ground up in the grinder. The forces exerted on the cutting blade are primarily compressive and urge the cutting blade against the holder and the holder against the breaker head, and the cutting blade defines a sharpened ridge at its outermost edge to form a cutting edge, and the cutting edge is heat hardened.

5 Claims, 3 Drawing Figures

PATENTED FEB 15 1972

3,642,214

INVENTOR
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BY

Jones & Thomas

ATTORNEYS

3,642,214

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CUTTER TOOTH ASSEMBLY FOR GRINDER

BACKGROUND OF THE INVENTION

In the past, various machines have been developed for the purpose of grinding up wood, soft metal, and the debris carried with these and other scrap substances. The machines usually comprise a rotor having a plurality of teeth that pass through relatively small openings formed by anvils or similar hard structures. An object to be ground up is dropped onto the rotor which revolves at a high angular velocity and the teeth gouge away portions of the object and force the material through the openings in the anvil.

While machines of this nature have been in common use for an extended period, the teeth of the rotor are subject to rapid wear and deterioration and must be replaced from time to time. The teeth of the rotor perform virtually all of the grinding of the objects to be ground up and are usually arranged with respect to the rotor so that they encounter virtually all of the compressive and impact forces. The teeth therefore must be extremely strong and are usually large and expensive.

As the teeth of the rotor wear, they become rounded about their edges and less effective in their grinding or cutting function. Thus, it is usually desirable to replace the teeth frequently to attain optimum rotor cutting characteristics for a given power input to the rotor; but the cost of the teeth and the labor costs required to replace the teeth are so excessive that they are not usually replaced with the frequency required to maintain good cutting characteristics from the rotor.

Moreover, the cost of new teeth is such that worn teeth are usually removed from the rotor, transported to a device for sharpening teeth, and transported back to the grinding machine where they are reconnected to the rotor. Obviously, the delay time encountered in the sharpening process is expensive and onerous, and it is necessary to maintain a complete set of sharpened teeth at the site of the grinder to minimize the downtime of the grinder. While some of the grinders are permanently located at the site of the mill, others are portable and used along railroad tracks to grind crossties, etc., or are transported between different mill sites, and it is difficult to maintain a supply of extra cutting teeth with the grinder and to transport the worn cutting teeth to a machine for sharpening the teeth.

SUMMARY OF THE INVENTION

Briefly described, the present invention comprises a cutter tooth assembly for a rotor of a grinding machine of the type used for grinding wood, paper, paperboard and the various types of debris carried by these substances. The grinder includes a rotor having alternate large and small diameter breaker rings and at least one breaker head protruding from each breaker ring. The cutter tooth assembly includes a holder connectable to a breaker head and a relatively small and inexpensive cutting blade fastened to the holder. The cutting blade is positioned by the holder so that it forms the primary cutting and impact surface of the rotor and thus is the portion of the assembly most subject to wear. A worn cutting blade is conveniently and expediently removable from the holder, and can be discarded without any substantial financial loss, and a supply of new cutting blades can be conveniently maintained with the grinder.

Thus, it is an object of this invention to provide a cutter tooth assembly which is inexpensive to manufacture, lasts for a prolonged time in heavy wear conditions, and which has removable portions thereof that are easily replaceable and are inexpensive.

Another object of this invention is to provide a cutting blade for a cutter tooth assembly that is inexpensive, shaped with a cutting edge that withstands high compressive impact forces and substantially retains its shape after prolonged wear.

Other objects, features and advantages of the present invention will become apparent upon reading the following specifications, when taken into conjunction with the accompanying drawing.

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BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a rotor and anvil assembly of a grinder.

FIG. 2 is a partial side cross-sectional view of the rotor.

FIG. 3 is a perspective view of one of the breaker rings of the rotor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in more detail to the drawing, in which like numerals indicate like parts throughout the several views, FIG. 1 shows grinder 10 that includes rotor 11 rotatable about an axis 12. Rotor 11 comprises a plurality of alternately large and small diameter breaker rings 14 and 15 and each breaker ring 14 and 15 carries at least one breaker head 16 or 17. A tooth assembly 18 is carried by each breaker head 16 or 17. The tooth assemblies and breaker heads are arranged to pass adjacent anvils 19 and 20, with the smaller anvils 19 defining larger spaces 21 for the breaker heads and teeth assemblies 16 and 18 and the larger anvils 20 defining smaller spaces 22 for the passage of the breaker heads 17 and teeth assemblies 18 of smaller diameter breaker rings 15. If desired, smaller diameter breaker ring 15 and its breaker head 17 can be displaced inwardly of the outer periphery of larger diameter breaker ring 14 so that the larger anvils 20 protrude into the spaces between the larger diameter breaker rings 14. This assures that the ground up material is small enough to pass through spaces 21 and 22.

As is best shown in FIGS. 2 and 3, breaker heads 16 and 17 protrude radially outwardly from the center of rotor 11 and include rounded outer surface 24, flat leading surface 25, and flat trailing surface 26. To emphasize the shape of each breaker head without requiring the breaker head to extend a large distance from the surface of its breaker ring, each breaker ring is undercut to form recesses 28 and 29 adjacent the leading and trailing surfaces of each breaker head.

Each cutter tooth assembly 30 is fabricated of relatively hard material, preferably a ferrous metal, and is connected to the leading surface of each breaker head 16 or 17 and comprises holder 31, cutting blade or bit 32, and bolt 33. Holder 31 comprises a substantially flat sided support block 34 which includes rear surface 35, side surfaces 36, bottom surface 37, top surface 38, and front surface 39. The junction between rear surface 35 and bottom surface 37 is rounded and corresponds to the rounded junction between leading surface 25 of the breaker head and recess 28. Side surfaces 36, bottom surface 37 and top surface 38 extend substantially perpendicular to rear surface 35. Front surface 39 is substantially flat and slopes away from rear surface 35 from bottom surface 37 toward top surface 38. The angle of the slope between front surface 39 and rear surface 35 is approximately 13° to 15°. Slot 40 is defined in front surface 39 and includes inner surface 41 that is substantially parallel to front surface 39 and ledge surface 42 that is substantially perpendicular to inner surface 41. Slot 40 extends from side surface to side surface of the support block 34 and extends downwardly from top surface 38 toward bottom surface 37. A pair of apertures 44 are defined in support block 34 and extend from rear surface 35 through inner surface 41. Cylindrical boss 45 extends at a right angle from rear surface 35 of the support block. Cylindrical boss 45 defines an internally threaded bore 46 therein.

Cutting blade 32 is sized and shaped to fit slot 40 of support block 34 and comprises rear surface 45, side surfaces 46, bottom surface 47, top surface 48 and front surface 49. Top surface 48 extends at an angle of approximately 105° from rear surface 45. Bottom surface 47 normally abuts ledge 42 of slot 40, and rear surface 45 is normally juxtaposed inner surface 41 of support block 34. The width, height and thickness of cutting blade 32 is gauged so that the cutting blade substantially fills slot 40 and its side surfaces 46 form extensions of side surfaces 36 of support block 34, its front surface 49 forms an extension of the front surface 39 of support block 34, and its top surface 48 forms an extension of top surface 38 of the support block.

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A pair of apertures 50 are defined in cutting blade 32 and extend from rear surface 45 through front surface 49 and are placed so as to be in alignment with apertures 44 extending through support block 34. Apertures 50 of cutting blade 32 are internally threaded and bolts 51 extend through apertures 44 from the rear surface 35 of support block 34 and threadably engage the threaded apertures 50 of cutting blade 32. This secures cutting blade 32 in slot 40 of holder 31.

The front surface 49 of cutting blade 32 comprises a shallow rounded groove 52 that extends from side surface to side surface of the cutting blade adjacent its top surface 48, to form cutting ridge 54 at the junction of top surface 48 and front surface 49. Cutting ridge 54 is heat treated so that it is very hard and able to withstand excessive forces and extensive wear before becoming dull. The configuration of cutting ridge 54 is such that even after a portion of its sharpened cutting edge has been worn away, the junction between front surface 49 and top surface 48 still remains relatively sharp since top surface 48 and front surface 49 are disposed at an acute angle of approximately 75° to 77°. Thus, cutting blade 32 maintains an effective cutting shape even after it has been worn away to a substantial extent.

Apertures 44 of holder 31 extend substantially perpendicular to inner surface 41 of slot 40 and are shaped so that they conform to the shape of the shanks and heads of bolts 51. When bolts 51 are inserted through holder 31 and threaded into the threaded apertures 50 of cutting blade 32, their heads will be recessed in the rear surface 35 of holder 31.

Through bore 55 is defined in each breaker head 16 and 17, and a counterbore 56 is defined in the leading surface 25 of each breaker head to form a socket to receive the boss 45 of the holder 31. When a holder 31 has its boss 45 inserted into socket 56, the rear surface 35 of the holder will abut the leading surface 25 of the breaker head, and the bottom surface 37 of the holder will be positioned in the recess 28 of the breaker ring. The bolt 33 is inserted through the bore 55 and threaded into the threaded bore 46 of boss 45 to hold the tooth assembly in juxtaposition against the leading surface 25 of the breaker head.

OPERATION

When a grinder as illustrated in FIG. 1 is operated by the rapid rotation of rotor 11, the material to be ground up is allowed to fall by gravity down into contact with rotor 11. The material will be engaged by cutting blades 32 as the rotor rotates. The cutting ridge 54 of each cutting blade 32 will bite into the material and sever and wedge chunks of the material away from the main body of the material. The tooth assembly passes adjacent anvils 19 and 20 of grinder 10 on each revolution with rotor 11, so that if any particles of the material moving with the tooth assembly happen to be larger than the spaces 21 and 22 between the anvils and the breaker rings 14 and 15, the tooth assembly 30 will break up these particles so that they will pass through the spaces. The side surfaces 46 and top surfaces 48 of the cutting blades function with a scissors motion with the sides of anvils 19 and 20 to sever and grind the material at this point.

Since the sharpened edge 54 at the junction of top surface 48 and front surface 49 of each cutting blade 32 is heat treated and extremely hard, the ridges will last for a prolonged time before they become worn away and dull. Moreover, since the angle between top surface 48 and front surface 49 of each cutting blade 32 is an acute angle of approximately 77°, a relatively sharp edge should always be present at the junction of these surfaces. Furthermore, the shallow rounded groove 52 adjacent top surface 48 of each cutting blade 32 assures that the sharpness of the ridge 54 is emphasized on the new blades, and when the new blades begin to wear away, the sharpness of the ridge is maintained for an extended time due to the depth of rounded groove 52.

The recesses 28 in breaker rings 14 and 15 allow the bottom portion of each holder 31 to be substantially shielded from im-

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pact against the material being ground up in grinder 10. Thus, the primary impact will be encountered by cutting blades 32 and the cutting blades will be inclined to wear faster than holder 31 or breaker heads 16 and 17. Thus, the smallest and least expensive part of the assembly is positioned at the critical wear points about the assembly.

When it is desirable to replace worn cutting blades with new cutting blades, bolt 33 extending from the rear surface 26 of the breaker heads is loosened so as to urge its holder 31 away from front surface 25 of the breaker head. In many cases, the bolt 33 does not have to be completely removed from bolt 46 of the tooth assembly and bolts 51 extending through the back of support block 34 of holder 31 can be reached and loosened to remove cutting blade 32. It should be noted that bolts 51 extend through support block 34 at an angle which enables a tool to reach the heads of the bolts without having to move holder 31 a large distance away from its breaker head. Moreover, when bolts 51 have been loosened, cutting blade 32 will fall away from holder 31 and a new cutting blade 32 can be positioned adjacent holder 31 and the bolts 51 tightened again. After bolts 51 have been tightened, bolt 33 can be tightened.

In some situations it is desirable to completely remove holder 31 from its breaker head. In these situations, bolt 33 is merely backed off the holder to be removed and then inserted into the replacement holder, in a rapid operation.

The threads of bolts 51 and the threads of bolts 33 are located so that they are never subject to wear and abrasion by the material being ground up. Moreover, bolts 51 and 33 should encounter virtually no impact forces or shear forces due to the impact of the material against the blades since the forces encountered by cutting blade 32 will be transmitted back through holder 31 to the breaker head. Moreover, the boss and socket arrangement between holder 31 and the breaker head is such that the centrifugal forces felt by the relatively heavy holder 31 will be born primarily through the boss and socket, and not by bolt 33. It should be noted that two bolts 51 are provided to bear centrifugal forces exerted on cutting blades 32 and that the angle of inner faces 41 of holders 31 is such that it bears a substantial amount of the centrifugal forces applied to cutting blades 32 which further minimizes any shear forces felt by bolts 51. In addition, bolts 51 will be trapped between its holder 31 and its breaker head so that there is virtually no chance of one or both of the bolts 51 becoming loosened by the operation of the assembly.

While this invention has been described in detail with particular reference to a preferred embodiment thereof, it will be understood that variations and modifications can be effected with the spirit and scope of the invention as described hereinbefore.

I claim:

1. A cutter tooth assembly for a rotor of a grinder of the type used for grinding wood, scrap, or the like, comprising a holder and a cutting blade, said holder comprising a support block with a substantially flat rear surface having a cylindrical boss extending perpendicularly therefrom, and substantially flat bottom, top and side surfaces extending substantially normal to said rear surface and a substantially flat front surface sloping away from said rear surface from said bottom surface toward said top surface, a flat-sided slot defined in said support block and extending across said front surface from the edges of said sides and top surfaces and defining an inner surface and a ledge surface, and at least one aperture defined in said holder and extending from said rear surface to said inner surface, said cutting blade being sized and shaped to occupy said slot and comprising a rear surface juxtaposed said inner surface, a bottom surface juxtaposed said ledge surface and side, top and front surfaces forming extensions of the side, top and front surfaces of said holder, and at least one aperture defined in said cutting blade and extending from its rear surface to its front surface and positioned in alignment with the aperture of said holder, and connecting means extending through the apertures of said holder and cutting blade to hold said cutting blade in the slot of said holder.

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2. The invention of claim 1 and where the front surface of said cutting blade defines a groove extending from one of its side surfaces to the other of its side surfaces adjacent its top surface to form a sharpened edge along the intersection of the front surface with the top surface.
3. The invention of claim 2 and wherein said cutting blade is fabricated of a ferrous metal and said sharpened edge is heat hardened.
4. The invention of claim 1 and wherein the top surface of said cutting blade slopes away from its bottom surface from the rear surface toward the front surface.
5. A rotor assembly for a grinder of the type used to grind wood, scrap, or the like, comprising a rotor with alternate

large and small diameter breaker rings, at least one breaker head positioned on and protruding from each breaker ring defining a substantially flat leading surface, a socket means defined in each breaker head and extending inwardly from said flat leading surface, a cutting tooth assembly positioned adjacent said flat leading surface and including a holder with a boss member extending into said socket, a cutting blade attached to said holder on the side thereof remote from said flat leading surface, said holder and said cutting blade defining aligned apertures, and a bolt extending through said apertures from said flat leading surface to lock said cutting blade to said holder.

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